Transport and magnetic properties of PtMnSb and related heusler alloys.

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In this thesis the results of the research on the properties of the XMnZ-type Heusler alloys are discussed. The reason for the recent interest in these materials was the discovery of the very large magneto-optical Kerr effect at room temperature of PtMnSb, and the very strong spin polarization of the p-type valence band in the Heusler alloys. According to the energy band calculations, in case of NiMnSb and PtMnSb, this polarization is even complete, i.e. at the Fermi level only electrons with one spin direction are present.

We found that CoMnSb, NiMnSb and CuMnSb have a crystal structure transition at temperatures below their melting point. The best specimens could be obtained by annealing at temperatures below these crystal structure transitions. AuMnSb was found to have an incongruent melting point.

Except CuMnSb which is an antiferromagnet, all the alloys studied are ferromagnetic. The effective magnetic moments, calculated from the magnetic susceptibility at temperatures above the Curie temperature, are smaller than expected from the magnetic saturation. We present a model which, except this effect, also explains the observed deviations from the Curie-Weiss law. The latter we ascribe to the depolarization (also local) of the valence band above the Curie temperature. In the resistivity of the alloys studied we find the same contributions as in the ferromagnetic metals: residual, phonon and spin disorder contributions.

The Hall effect of the Heusler alloys was measured from 4 K to temperatures above the Curie temperature. The ordinary (R_o) and the spontaneous (R_s) Hall coefficients are determined from these measurements. The decrease of R_o at low temperatures in NiMnSb and PtMnSb is ascribed to the decreasing $\vec{k}$-anisotropy of the scattering of the current carriers. In order to explain the temperature dependence of R_s, the model with skew scattering and side jump contributions is presented. From the fit of the experimental data to this model we conclude that the polarization of the charge carriers is proportional to the total magnetization. This is only possible if the spin polarization of the charge carriers has a local character, i.e. if the charge carriers are completely spin polarized, locally, also above 0 Kelvin. Last conclusion is also in agreement with our interpretation of the ordinary Hall effect and the susceptibility behaviour.

The local character of the spin polarization of the valence band holes suggests that the present theories on the exchange coupling of the magnetic moments and the theory on the conduction in XMnZ-type Heusler alloys, should be revised.